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A numerical framework of the phenomenological plasticity and fracture model for structural steels under monotonic loading

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Abstract. In this study, the classical J2 flow theory is explicitly proved to be inappropriate to describe the plastic behaviour of structural steels under different stress states according to the reported test results. A numerical framework of the characterization of the strain hardening and ductile fracture initiation involving the effect of stress states, i.e., stress triaxiality and Lode angle parameter, is proposed based on the mechanical response of structural steels under monotonic loading. Both effects on strain hardening are determined by correction functions, which are implemented as different modules in the numerical framework. Thus, other users can easily modify them according to their test results. Besides, the ductile fracture initiation is determined by a fracture locus in the space of stress triaxiality, Lode angle parameter, and fracture strain. The numerical implementation of the proposed model and the corresponding code are provided in this paper, which are also available on GitHub. The validity of the numerical procedure is examined through single element tests and the accuracy of the proposed model is verified by existing test results.

Keywords: structure steels; strain hardening; ductile fracture; stress triaxiality; Lode angle parameter